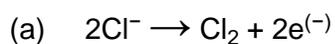


Mark schemes

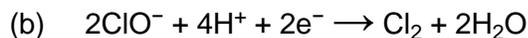
1



Allow $2\text{Cl}^- - 2\text{e}^- \rightarrow \text{Cl}_2$

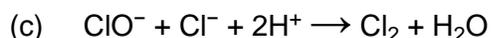
Allow correct equation forming ClO^- but not Cl^+

1



Allow HClO in correctly balanced equation

1



allow $\text{HClO} + \text{HCl} + \rightarrow \text{Cl}_2 + \text{H}_2\text{O}$

1

(d) Goes brown (or shades of brown)

Allow black ppt/solid but NOT black solution or purple

1

Due to iodine or I_3^-

Correct $\frac{1}{2}$ equation scores M2 and M3

1

Because I^- oxidised

1

[6]

2

(a) Increasing atomic radius / shielding / number of shells / size (down group) or reverse argument

NOT 'molecules'

1

Decreasing attraction of nucleus/protons for shared (electron) pair / bond electrons

NOT if attraction for single electron implied

1

(b) (i) Electron acceptor / species that accepts electrons / species that gains electrons

NOT electron pair

NOT just 'gain of electrons'

1

(ii) Chlorine 0 to -1 / oxidation state/number of chlorine decreases
AND

Bromine -1 to 0 / oxidation state/number of bromine increases

Penalise if oxidised for chlorine and/or reduced for bromine

Credit oxidation states if labelled on equation

1

- (c) (i) $\text{H}_2\text{SO}_4 + 8\text{H}^+ + 8\text{e}^{(-)} \rightarrow \text{H}_2\text{S} + 4\text{H}_2\text{O}$
ALLOW $\text{SO}_4^{2-} + 10\text{H}^+ + 8\text{e}^{(-)} \rightarrow \text{H}_2\text{S} + 4\text{H}_2\text{O}$
ALLOW fractions/multiples
IGNORE state symbols
1
- (ii) $2\text{I}^- \rightarrow \text{I}_2 + 2\text{e}^{(-)}$
ALLOW fractions/multiples
IGNORE state symbols
ALLOW $2\text{I}^- - 2\text{e}^{(-)} \rightarrow \text{I}_2$
1
- (iii) $\text{H}_2\text{SO}_4 + 8\text{H}^+ + 8\text{I}^- \rightarrow \text{H}_2\text{S} + 4\text{H}_2\text{O} + 4\text{I}_2$
ALLOW
 $\text{H}_2\text{SO}_4 + 8\text{HI} \rightarrow \text{H}_2\text{S} + 4\text{H}_2\text{O} + 4\text{I}_2$
 $\text{SO}_4^{2-} + 2\text{H}^+ + 8\text{HI} \rightarrow \text{H}_2\text{S} + 4\text{H}_2\text{O} + 4\text{I}_2$
 $\text{SO}_4^{2-} + 10\text{H}^+ + 8\text{I}^- \rightarrow \text{H}_2\text{S} + 4\text{H}_2\text{O} + 4\text{I}_2$
 $9\text{H}_2\text{SO}_4 + 8\text{I}^- \rightarrow \text{H}_2\text{S} + 4\text{H}_2\text{O} + 4\text{I}_2 + 8\text{HSO}_4^-$
 $9\text{H}_2\text{SO}_4 + 8\text{NaI} \rightarrow \text{H}_2\text{S} + 4\text{H}_2\text{O} + 4\text{I}_2 + 8\text{NaHSO}_4$
 $\text{H}_2\text{SO}_4 + 8\text{H}^+ + 8\text{NaI} \rightarrow \text{H}_2\text{S} + 4\text{H}_2\text{O} + 4\text{I}_2 + 8\text{Na}^+$
 $5\text{H}_2\text{SO}_4 + 8\text{I}^- \rightarrow \text{H}_2\text{S} + 4\text{H}_2\text{O} + 4\text{I}_2 + 4\text{SO}_4^{2-}$
 $5\text{H}_2\text{SO}_4 + 8\text{NaI} \rightarrow \text{H}_2\text{S} + 4\text{H}_2\text{O} + 4\text{I}_2 + 4\text{Na}_2\text{SO}_4$
1
- (iv) 'Oxidising agent' box ticked
1
- (v) $\text{H}_2\text{SO}_4 + 2\text{NaF} \rightarrow \text{Na}_2\text{SO}_4 + 2\text{HF}$
OR
 $\text{H}_2\text{SO}_4 + \text{NaF} \rightarrow \text{NaHSO}_4 + \text{HF}$
1
- (vi) Fluoride less powerful reducing agent (than iodide)
OR
Fluoride less easily oxidised than iodide
Or reverse argument in either case
NOT general group VII trend statement
NOT fluorine/F or iodine/I
Must be comparative
1
- (d) (i) $\text{Cl}_2 + \text{H}_2\text{O} \rightleftharpoons 2\text{H}^+ + \text{Cl}^- + \text{ClO}^-/\text{HCl} + \text{HOCl}$
ALLOW \rightarrow for \rightleftharpoons
1

(ii) Equilibrium shifts/moves left

1

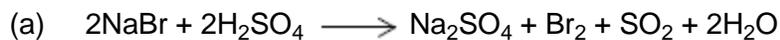
(Producing) chlorine (which) is toxic/poisonous

Mark independently

1

[13]

3



Allow ionic equation



1

Br^- ions are bigger than Cl^- ions

1

Therefore Br^- ions more easily oxidised / lose an electron more easily (than Cl^- ions)

1

- (b) This question is marked using levels of response. Refer to the Mark Scheme Instructions for Examiners for guidance on how to mark this question.

Level 3

All stages are covered and the explanation of each stage is generally correct and virtually complete. Stages 1 and 2 are supported by correct equations.

Answer communicates the whole process coherently and shows a logical progression from stage 1 to stage 2 and then stage 3. The steps in stage 3 are in a logical order.

5–6 marks

Level 2

All stages are covered but the explanation of each stage may be incomplete or may contain inaccuracies OR two stages are covered and the explanations are generally correct and virtually complete.

Answer is mainly coherent and shows a progression through the stages. Some steps in each stage may be out of order and incomplete.

3–4 marks

Level 1

Two stages are covered but the explanation of each stage may be incomplete or may contain inaccuracies, OR only one stage is covered but the explanation is generally correct and virtually complete.

Answer includes some isolated statements, but these are not presented in a logical order or show confused reasoning.

1–2 marks

Level 0

Insufficient correct chemistry to warrant a mark.

0 marks

Indicative chemistry content

Stage 1: formation of precipitates

- Add silver nitrate
- to form precipitates of AgCl and AgBr
- $\text{AgNO}_3 + \text{NaCl} \rightarrow \text{AgCl} + \text{NaNO}_3$
- $\text{AgNO}_3 + \text{NaBr} \rightarrow \text{AgBr} + \text{NaNO}_3$

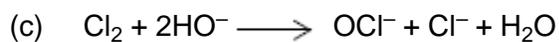
Stage 2: selective dissolving of AgCl

- Add excess of dilute ammonia to the mixture of precipitates
- the silver chloride precipitate dissolves
- $\text{AgCl} + 2\text{NH}_3 \rightarrow \text{Ag}(\text{NH}_3)_2^+ + \text{Cl}^-$

Stage 3: separation and purification of AgBr

- Filter off the remaining silver bromide precipitate
- Wash to remove soluble compounds
- Dry to remove water

6



1

OCl⁻ is +1

Cl⁻ is -1

Both required for the mark

1

[11]

4

A

[1]

5

D

[1]

6

Ideal gas equation: $pV = nRT$ (1)

Calculation: $n = pV/RT = \frac{103000 \times 127 \times 10^{-6}}{(8.31 \times 415)}$ (1)

mark for volume conversion fully correct

$= 3.79 \times 10^{-3}$ (mol) (1)

range 3.79×10^{-3} to 3.8×10^{-3}

$M_r = m/n = .304/3.79 \times 10^{-3} = 80.1$ (1)

range 80 – 80.3

min 2 s.f. conseq

If 'V' wrong lose M2; 'p' wrong lose M3; 'inverted' lose M3 and M4

[5]

7

D

[1]

8

Hydroxide: solubility increases

1

Sulphate: solubility decreases [BOTH inc/dec allow 1/2]

[Allow correct solubilities of top (Mg) and bottom (Ba) cpds]

1

Add: $BaCl_2(aq)$ / $Ba(NO_3)_2(aq)$ / $Ba(OH)_2(aq)$

[Not solid added]

[Not Ba^{2+} / Ba / Ba + HCl / $Pb(NO_3)_2(aq)$]

[If $BaSO_4$ / H_2SO_4 used, M3 to M6 = CE = 0]

[Allow any sensible nitrate test as an alternative to the sulphate test]

1

- (d) (i) 2 (1)
- (ii) Two elements (or Na / Mg) before the drop (in energy) to Al (1)
- (iii) ionisation energy of Al < that for Mg (1)
- (iv) fall in energy from P to S (1)
or discontinuity in trend

From Al to P there are 3 additional electrons (1)
or three elements
For second mark idea of block of 3 elements

5

[12]

10 C

[1]

- 11 (a) Mg⁽²⁺⁾ or Magnesium
Na⁺ CE=0

1

Because Mg²⁺ has more protons
 AND

With the same shielding/screening/electron arrangement/number of
 electrons (or isoelectronic)

Allow larger/stronger nuclear charge
Ignore atomic radius

1

- (b) Na(g) → Na⁺(g) + e⁻
1 for correct species and gas phase
Allow e without charge
Allow Na(g) - e⁻ → Na⁺(g)
Na(g) + e⁻ → Na⁺(g) + 2e⁻

1

- (c) Mg between 600-800 1
- S between 800-1040
- If S not lower than P on graph then M1 only*
- If no plots on graph must state S below P to access M3 & M4* 1
- e⁻ paired in (3)p orbital in S (owtte)
- Allow (3)p subshell/sublevel provided pair mentioned* 1
- Paired e⁻ repel (so less energy needed to remove) 1

[7]

12

- (a) **Q** is calcium or magnesium 1
- bromide 1
- R** is aluminium 1
- chloride 1
- S** is iron(III) 1
- sulfate 1

Mark this question independently

- (b) $\text{Ba}^{2+} + \text{SO}_4^{2-} \longrightarrow \text{BaSO}_4$ 1
- $[\text{Fe}(\text{H}_2\text{O})_6]^{3+} + 3\text{OH}^- \longrightarrow \text{Fe}(\text{H}_2\text{O})_3(\text{OH})_3 + 3\text{H}_2\text{O}$ 1
- $2[\text{Fe}(\text{H}_2\text{O})_6]^{3+} + 3\text{CO}_3^{2-} \longrightarrow 2\text{Fe}(\text{H}_2\text{O})_3(\text{OH})_3 + 3\text{H}_2\text{O} + 3\text{CO}_2$ 1
- $[\text{Fe}(\text{H}_2\text{O})_6]^{3+} + 4\text{Cl}^- \longrightarrow [\text{FeCl}_4]^- + 6\text{H}_2\text{O}$ 1

[10]